REMARKS

The examiner provisionally rejected claims 1, 4-8, 10-22 and 98 under the judicially created doctrine of obviousness-type double patenting as being unpatentable over claims 1, 98-115 of U.S.S.N. 12/815,189. To address this rejection we are submitting herewith a terminal disclaimer.

The examiner rejected claims 1 and 4 under 35 U.S.C. §102(b) as anticipated by U.S. 5,745,535 to Mori.

We note, however, that Mori is about the use of a QAM modulation scheme in a digital communication system. A method of generating a signal using QAM is not "a method of generating a navigation ranging signal in a navigation system…" Therefore, we submit that Mori does not anticipate claim 1.

One skilled in the art would appreciate that there are fundamental differences between communication systems and navigation systems to the extent that they are different technical fields, notwithstanding the seductive ostensible similarity between them. The skilled person in each case is not one and the same person. This becomes much more apparent when one considers the difference between communication spectra and navigation spectra and associated issues.

1. Considering *Mori*, in particular, Fig. 5 and col. 1 and col. 2, line 4, it can be appreciated that *Mori* is focused on the reception of digital signals via a digital *communication* link which have been processed for transmission in a spectrally efficient way. Specifically, *Mori* discloses a two step process of achieving timing synchronism with the received signals in order to minimize the data bit error rate.

2. Referring to Fig. 5 of *Mori* there is shown a serial to parallel converter that, in the figure, splits the data stream into 4 separate paths, each of which has words of 4 bits. The data input to the serial to parallel converter is at the highest rate that the channel can support through its bandwidth limitations. The data input would be of a random nature to maximize

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the entropy of the signal. In practice, the entropy of the input signal is determined by the frequency of each letter of the digital alphabet of the source.

3. Each of the four paths is then encoded with an orthogonal digital code. The use of orthogonal codes is well known in the digital communications industry. The codes have the effect of randomizing the data stream for transmission thus maximizing the information carrying capacity of the channel. Such codes are commonly used to provide for the reduction (usually to a low level) of inter-symbol interference. In the case of Fig. 5, the codes provide for the separation of information flow along each of the 4 digital channels. Each of the encoders produces 4-bit vectors (with 16 levels) in response to 4-bit word inputs.

4. The output of each encoder is then passed through a transmission filter 4 to minimize the bandwidth used for each signal path and, according to col. 1 of *Mori*, a frequency reduction to baseband. The effect of this coding, combined with the modulation by sub-carriers $(\omega_1..\omega_4)$, is to produce a spectrum of the form shown below (for illustration purposes). The examiner is invited to notice the introduction of guard bands to provide additional protection between each sub-band for mutual interference reduction. The illustrative diagram shows 4 sub-bands at 4 frequency units spacing, each of which has an individual bandwidth of ~3.5 units. This is in general accordance with Fig. 5 of *Mori* and digital communications principles.
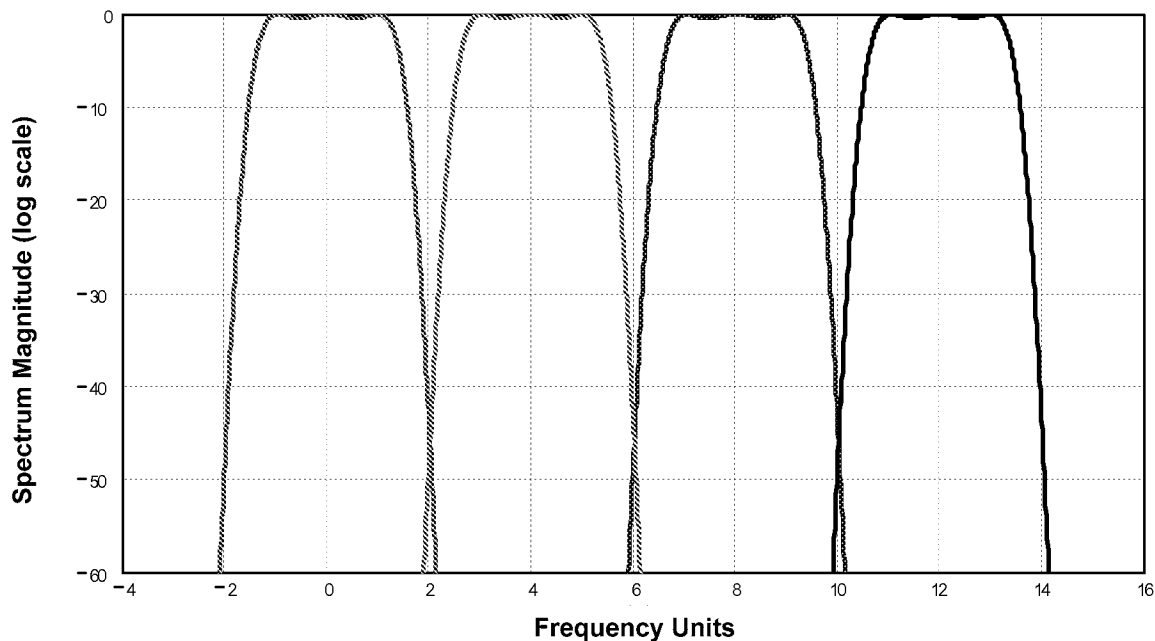
5. The diagram clearly indicates an intention to <u>prevent</u> interference between each sub-band by ensuring that no spectral overlap at high level occurs. The interference rejection between the sub-bands is further enhanced using the orthogonal codes, one for each band. Upon decoding, any signal from a non-desired band is converted into the equivalent of a random noise component. This lowers the bit error rate but by an amount that can be designed into the communication link.

6. By contrast, in navigation system design, there are multiple conflicting objectives. Two of these are to improve the ability to measure range to each of the usually orbiting satellites as well as the desire to minimize interference with other satellite navigation signals that exist to operate separate services.

7. The ability to measure range can be established using the Cramer-Rao Lower Bound (CRLB) as representing the performance of the best maximum likelihood, unbiased estimator as would be well-known to one skilled in the art of navigation signals and system, as opposed to digital communication signals and systems. One of the significant parameters

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in the CRLB is the Gabor bandwidth of the transmitted signal. The Gabor bandwidth is defined as:

$$\vartheta = \frac{1}{2\pi} \int_{-\infty}^{\infty} \omega^2 \Phi(\omega) d\omega$$

Consequently, one skilled in the art appreciates that the Gabor bandwidth is improved by having signal energy placed at a maximum spacing from the centre transmission frequency.

8. As there are typically many signals competing for occupancy of the radio navigation bands (RNSS and ARNS bands), the design challenge is to ensure that the spectra of the various signals are controlled so that they do not overlap in critical regions. This can be illustrated by the new GNSS MBOC and the GPS M-code spectra shown below.

Red (PRS)   Blue (M-code)   Magenta (MBOC)   Black (Uniform Spectrum Signal)
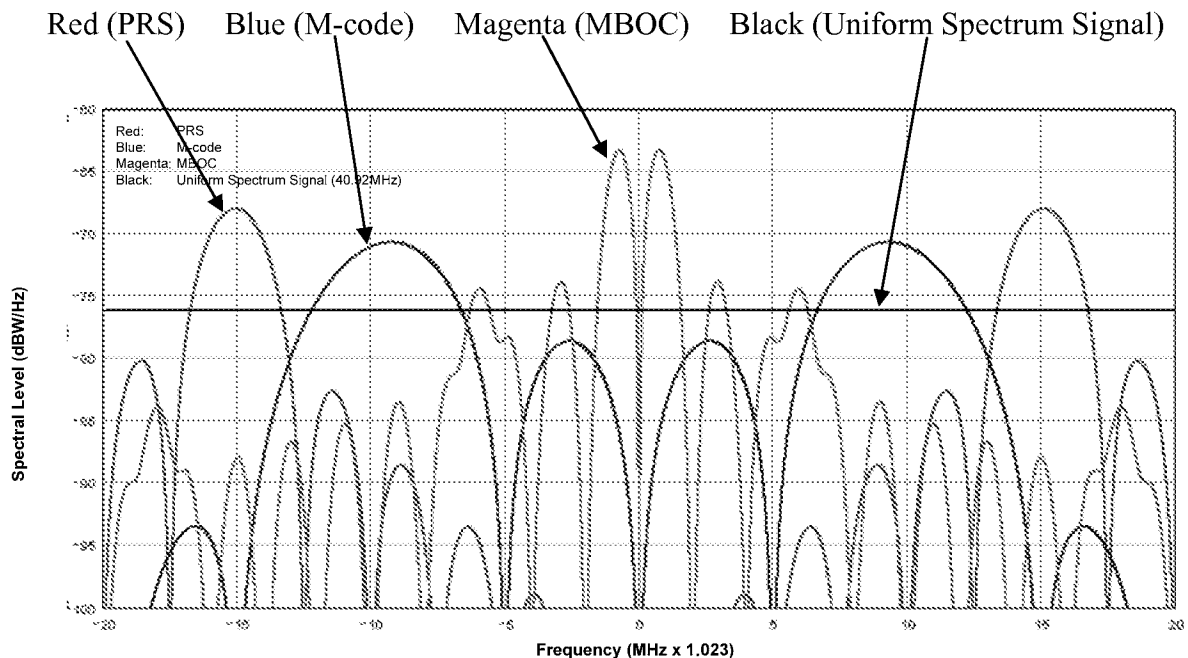
9. This graph has a vertical logarithmic scale covering only 40dB (much smaller than the communication spectrum graph), corresponding to 1 watt of energy for each signal. This

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shows the current expected spectrum in the L1 RNSS band centered at 1575.42MHz. The graph excludes C/A and P(Y) code signals, which are in the centre of the band. The MBOC signal is illustrated in magenta, the US military M-code spectra is in blue and the Galileo PRS signal in red.

10. The spectral plot clearly shows how the signals overlap, driven by many design constraints. The MBOC spectrum has 'wings' at ±18MHz from the centre of the band. These parts of the signal significantly enhance the Gabor bandwidth but do not significantly interfere with M-code or PRS signals, partly due to the use of CDMA techniques to separate each satellite and signal from all of the others. The presence of the 'wings' significantly enhances the multipath performance of the signal.

11. Consequently, the essence of these spectrum design constraints is to *control* the spectrum of the signal (being designed) so that its energy peaks do not coincide with the energy peaks of other signals. For example, the MBOC ±18MHz components are located near nulls in both the PRS and M-code spectra. Furthermore, the MBOC components at ±6MHz are also located near nulls in the M-code spectra and at frequencies where the PRS spectrum is at a low levels because it is a $BOC_{cosine}(15,2.5)$. The cosine phasing reduces the spectrum level between its two peak components compared with sine phasing.

12. The interaction (or leakage) of one signal spectrum into another is controlled by the Spectral Separation Coefficient, κ:

$$\kappa = \frac{1}{2\pi} \int_{-\infty}^{\infty} \Phi_1(\omega) \cdot \Phi_2(\omega) d\omega$$

13. The MBOC spectrum was designed using the present invention in order to maintain the spectral separation coefficient, κ, at acceptable levels. It can be appreciated that these design constraints are different from those applicable to digital communication system design. One would not be directed to digital communications system design to solve

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problems in satellite navigation system design as the techniques taught by the two disciplines are quite different.

14. It is submitted, therefore, that embodiments of the present invention are not obvious to one skilled in the art and that art relating to digital communication signals and systems is at best unhelpful to one skilled in the art of navigation signals and system and at worst positively counter from a technical perspective to the aims of one skilled in the art of navigation signals and system.

For at least the reasons stated above, we believe that the claims are in condition for allowance and therefore ask the Examiner to allow them to issue.

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Respectfully submitted,

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